THE VIOLIN

AND THE ART OF ITS CONSTRUCTION.

A Treatise on the Stradivarius Violin

by

AUGUST RIECHERS,
Bow and Violin Maker.

With four lithographed plates.

GOETTINGEN.
CARL SPIELMEYER'S NACHFOLGER.
FRANZ WUNDER.
1895.

To his highly revered Friend and Patron

DR. JOSEPH JOACHIM

this work is humbly dedicated

by

THE AUTHOR.

To his highly revered Friend and Patron

DR. JOSEPH JOACHIM

this work is humbly dedicated

by

THE AUTHOR.

PREFACE.

The highly esteemed author of this treatise, a renowned violin maker and clever repairer of old instruments, having been denied the pleasure of publishing the same himself, death intervening on January 4th, 1893, his work on the violin and the art of its construction is now published, in accordance with his last wishes.

This treatise will, no doubt, be all the more welcome to professionals and amateurs alike, as to my knowledge no such work has yet been published treating the subject in such an able and thorough manner.

May, therefore, the valuable labours of the deceased author meet with that universal acknowledgment, which in a very high degree they deserve.

Göttingen, April 1895.

The Editor.

Index.

INTRODUCTION.

In giving publicity to this treatise on the construction of the violin, I believe I am only meeting the wishes of many, both professionals and amateurs, who are desirous of learning more particulars concerning the construction of their instruments, but am also giving a few practical hints to my younger comrades in the art of violin-making. I hope also to induce some of my older colleagues to give forth other works of the same kind, which may serve to ennoble and promote our art.

Times without number I have been asked by friends of the violin, during my 40 years' work as a violin maker, to recommend books giving more exact information on the construction of that instrument, but the only answer that I have been able to give has been that German technical literature on the subject is very meagre, and that information from foreign works is mostly impoverished by feeble translations.

Very few authors understand the general build of the violin thoroughly, they pay most attention to individual points, those most calculated to attract the attention of amateurs; for example, the proportions of single parts, their size, etc. There is only one work I can recommend which forms an exception to this rule and that is "The Memoirs of Antonio

Bagatella" (Padua 1786) which has been published in a German translation by Franz Wunder at Göttingen.

It contains not only rules for the construction of violins, violas, violincellos and basses, as well as distinct instructions for the restoration of the outline of the belly and back of these instruments, but also enters into particulars concerning the adjustment and renovation of the same.

Just as the celebrated violin makers of the last century took the work of Amati as their model, I have found my master, to whom I, in common with all my colleagues, look up with admiration, recognising in him not only the gifted artist, but also the industrious workman and far-sighted observer — I mean Antonio Stradivarius. Even as a boy I was very fond of listening to the tales told me by my father, who was a musician in Hanover and as an autodidact occupied himself with violin work, tales in which he described to me the wonderful productions of the old Italian masters and more particularly those of Amati, Stradivarius, and Guarnerius. He regarded it as a great distinction shewn to him, and often referred to the fact, that he was allowed to open and repair the Guarnerius violin of Paganini. After a time, however, he altered his tone and cursed the Italian as well as his violin, for the great artist, although he praised my father's work and expressed himself perfectly satisfied with it, objected to the payment of three Thalers for the repairs, considering it an exorbitant charge, and this, coupled with similar experiences at the hands of others, so incensed my father that he would not give his consent to my earnest wish to enter the violin factory; consequently I was apprenticed at the age of 13 years to a pianoforte manufacturer with whom I remained for two years, in spite of having shown aptitude in the other direction by constructing a violin with my own hands at the age of 12 years.

Being released from my apprenticeship at the beginning of my fifteenth year, I wandered away to Markneukirchen, there to study violin-making under Hans Ficker; later on I was occupied for a longer period as assistant to Ludwig Bausch, senior, in Leipsic, to whom I owe a great deal, for he strengthened me in my love of the art and settled my belief in the unequalled excellence of Stradivarius. My admiration for this great master increased even more and more, and in my fifteenth year, when I began to work for myself in Hanover, I learned even more of his works and had the happiness to find that my reverence for him was shared by my friend and patron Dr. Joseph Joachim. Ten years later, the latter exchanged Hanover for Berlin, and as I was no longer contented in the former town after his departure in 1872, I gladly responded to a call from him to prosecute my work in the Prussian capital and to continue to study the works of Stradivarius, in order to handle them more worthily and to infuse his ideas into my own productions. I venture to hope that I have succeeded in the first part of my undertaking, for, a great number of instruments have passed through my hands in the course of years, including the incomparable violins belonging to Dr. Joachim. The second part of my task I do not consider accomplished. I am ever taking more and more trouble in working, in the hope of bringing my attempt nearer and nearer to the hitherto unattained excellence of Stradivarius. I therefore beg my readers to regard the following chapters with a favourable eye and to accept them in a friendly spirit as the result of long years of experience, the confirmation or rectification of which I shall accept with joy.

I. OF THE WOOD.

THERE can be no doubt whatever that a correct knowledge and choice of the wood for the construction of violins is of the utmost importance. Both these qualifications, however, can only be gained by experience, since that alone can prove which kind of wood is the most suitable and produces the best results.

The back, the ribs, the neck, and the head should be of maple, and neither too hard, nor too soft, nor yet too deeply grained. In every case light wood should be selected, and I consider Hungarian maple the best for the purpose. For the belly, the so-called white fir or pine should be used, as both kinds of wood possess sufficient resonance, and are easily manipulated. These woods too must be as light as possible, and should have neither very narrow nor very broad, but regular and well-formed concentric circles. The Tyrol and the neighbouring cantons of Switzerland produce the best wood for this purpose. It is to be observed that the pieces used must be split and not cut.

In my opinion, the much praised American pine is too soft and resinous, and neither do I consider the American maple qualified for the construction of violins. The wood used by myself is obtained from Schoenbach, near Eger, in Bohemia, where large supplies for the needs of intsrument

makers are always on hand to be selected from. The age of the wood I consider of only very small importance; if it has been laying by for five years, ready cut or split, as the case may be, for the construction of a violin, it will then be sufficiently dry and will need no further preparation. I have exactly ascertained the weight of wood which had been laid by for drying for five years, and then, having weighed it again at the end of twenty years, have found it had not become perceptibly lighter. All the violins made by me, some 1600 instruments, have always weighed from 260 to 275 grammes, without the pegs, finger-board, and tail-piece, a weight which I have generally found to be that of the violins constructed by Stradivarius.

II. OF THE CONSTRUCTION.

For the space of thirty years I have worked upon the plan of Stradivarius solely, for I consider that his instruments and their proportions are the most perfect that can be found. Why, therefore, should I have taken any other as my model? I have repaired at least three hundred undoubtedly genuine violins constructed by this great master, besides having seen and handled many others, and consequently have had frequent opportunities of thoroughly studying his work, and of gauging and copying his most beautiful instruments. As the creations of this incomparable maker seem perfect in every detail, I have never attempted to make any additions of my own, but have strictly adhered to specimens produced by him in his prime (1700 to 1720) as my models, and have found that they differ but very slightly from one another. In Fig. I., I have given the outlines of a violin of this period (1713) with the blocks.

III. THE RIBS (Fig. I. a).

The ribs should be 1½ m/m. thick, and very neatly and evenly planed; the height should be about 30 m/m. at first. The ribs are curved to their correct form by means of a hot bending iron, or still better by a copper clew, and then glued to the blocks. After this, the ribs next to the back are to be made true to receive the linings. The latter must be 8 m/m. high, 2½ m/m. thick, and must be made of lime-wood. The middle linings are to be let into the blocks, so that they cannot break loose. The blocks must also be made of lime-wood. The edges of the ribs and the surface of the rim, before being glued on to the prepared back, must again be very carefully adjusted, so that they appear like one even surface. This being done, the superfluous wood of the blocks must be cut away to the shape of the mould (*see* Fig. 5). The ribs from the bottom block to the side blocks are then regulated to a height of about 30 m/m., and from the side blocks to the top block (Fig. 3) they are gradually decreased by 2½ m/m., that is, until 27½ m/m. is reached. This diminution in the height is most practically thought out and executed by Stradivarius, the belly obtaining thereby a tension which offers the necessary resistance to the neck. The upper linings must be adjusted to the ribs in the same way, and as a matter of course, they must be curved to the shape of the ribs. The superfluous wood of the blocks being cut away, the mould is removed.

IV. THE BACK AND EDGES.

It is not of importance whether the back be made in one or two pieces; nevertheless, Stradivarius seems to

have given the preference to a divided back. I also consider it more advantageous, as, being joined, it offers greater resistance, and is not so easily pressed outwards on the sound-post side, as is the case with violins having the back cut in one piece. The edges of the mid-rib and corners should be 4 m/m. thick, whereas the upper and lower edges of the back (Fig. 1 $\frac{ee}{ee}$), gradually decreasing from the corners, become 1 m/m. thinner.

V. THE BELLY.

The belly must be composed of two parts, and has to be joined together so exactly that the narrow year-rings are in the middle of the same; the outer ring which should not be more than 2 m/m. broad and very equally disposed, may run towards the edges. The edges must be of the same thickness as those of the back.

VI. THE ARCHING.

It does not seem to me probable that Stradivarius acted without mature deliberation in making the arch of the back and belly, taken together, of the same height as the ribs, viz.: 30 m/m.; of course, I am speaking now of the violins made during his prime. If the back and belly are placed one upon the other, the height will amount to 30 m/m., the entire external diameter, therefore, must be 60 m/m., since the ribs, as already stated, have a height of 30 m/m. I am certainly of the opinion, that Stradivarius substantiated these proportions by experiments. There are, however, exceptions; the greatest of the deviations from this rule which has come under my notice, consisted in the middle line measuring 70 m/m., reckoning from the upper edge of the belly to the

lower edge of the back. No doubt, this violin, made in 1710, was an experiment, the average measurement being considered to be from 58 to 62 m/m. Now and again, Stradivarius made the arch lower, whether intentionally or from want of wood, I am not in a position to say. In this case he makes the ribs correspondingly higher, so that the above-mentioned measurement may still be 60 m/m. Stradivarius has also occasionally made the arch of the back less than 15 m/m., and by way of compensation, in this case, has increased the arch of the belly. I am of opinion, however, that these deviations are to be ascribed more to experiment than to accident. He never trusted to chance in his work, but in the most careful way reflected upon it and took into consideration all circumstances in connection with it. The arch given as an example in Fig. 6, is taken from a Stradivarius violin of the year 1713, and as the belly and back are both of equal height, viz.: 15 m/m., the entire height amounts to 60 m/m.

VII. THE PURFLING.

The purfling is always placed 4 m/m. from the edge and is 1½ m/m. wide. It consists of three parts, the two outermost of which are prepared from maple and stained black, while the middle part is made of the same kind of wood, but unstained. It is of the utmost importance that the purfling should only be inserted to the depth of one-third of the thickness of the edges, otherwise the edge will very easily break off. In the work of Stradivarius, one finds continually on the back, both above and below, a peg of maple-wood, by means of which he fastened the back to the block, and the half of this peg is inserted in the purfling. In violins having a divided back, one finds another purfling on

the bottom block, along the joint of the ribs, but with backs made in one piece it scarcely ever occurs, because then the under ribs, as far as the middle rib, are prepared in one piece. The purfling is not to be regarded as an embellishment, as many suppose it is. It considerably strengthens the back and the belly towards the edges, and at the same time offers a protection, especially for the belly, against cracks, if the instrument, for example, should be opened for repairs by an inexperienced workman. I will even go so far as to assert that if the purfling were not employed, old violins could not exist without numberless cracks, for any violent blow would cause cracks, without the additional strength given by the purfling, and the greater number of old and costly violins would come down to us spoilt, or at least damaged.

The purfling also has this advantage that if perchance the edges get broken off, they can easily be replaced and the good appearance of the instrument restored without much trouble.

VIII. WORKING-OUT THE THICKNESSES OF THE BELLY AND BACK.

The thickness of the breast in the back amounts to 4 m/m. at the spot where the sound-post stands and remains the same to a distance of 50 m/m. towards the bottom block, and 60 m/m. towards the upper block, while it decreases to 3 m/m. towards the middle rib. The cheeks must be 1 to 2 m/m. thick. I have assured myself by numberless measurements that Stradivarius often changed the thickness of the back; and has even gone so far as to make it 6 m/m., while the belly which he made from the soundest and most perfect

wood, with very evenly disposed grain, measured always exactly $2\frac{1}{2}$ m/m.

IX. THE F-HOLES.

A well-formed and proportioned F has a great deal to do with enhancing the appearance of a violin. The F represented in Fig. 7 is a most perfect specimen of what it should be. Anyone wishing to cut the F-holes in the belly, should take Fig. 7 and place it in such a way that the line $\frac{a}{a}$ be exactly 195 m/m. from the outer and upper edge, and *b b* almost upon the point of the belly. This will give the right position of the F-holes and at the same time the measurement of the body. The greatest width of the opening of the F-holes must be 6 m/m. The width of the breast between the two upper excisions must never be narrower than the width of the bridge. In the accompanying illustration these are very wide apart and might without disadvantage be placed 2 m/m. nearer together. On violins where this distance of the F-holes is less than 40 m/m., either a narrower bridge must be used or the bass-bar must be cut out a little, so that the latter may lie close on to the upper F-hole. The lower lobes of the F-holes are always slanted outwards by Stradivarius, thus presenting a more symmetrical appearance. Both incisions are small, but clearly cut.

X. THE BASS-BAR.

After the F-holes have been cut out, the bass-bar can be fixed. It is made of pine and should be prepared in such a way that the year-rings lie perpendicularly to the belly. The height of the bass-bar under the bridge is 10 m/m. and at the two ends 4 m/m. The bass-bar must be

6 m/m. thick in the middle, decreasing in thickness by 1 m/m. towards the ends. The length should be 280 m/m. The bass-bar must be glued on so that it lies 35 m/m. from the bottom edge and 40 m/m. from the upper one. In order to determine exactly the position of the beam, the width of the bridge should be precisely marked as 40 m/m. on the inside of the belly and the bass-bar should then be placed to coincide exactly with the G-foot of the bridge, giving it at the same time such a slanting position as to bring its upper end within 4 or 6 m/m. of the middle line of the belly, while its lower end should, on the contrary, be purposely placed farther away from it. (*See* illustration).

In order that the bass-bar may obtain the right tension, the side of it lying next the belly must be slightly curved, sufficiently so for both ends, before they are glued, to stand away about 2 m/m. In the process of glueing, the ends must be firmly pressed down. The height of the bass-bar under the bridge should be 8 m/m., while at the ends the measurement should amount to 4 m/m. It is scarcely necessary to remark that the proportions of the bass-bar vary in different violins, according as they are smaller or larger, high or flat, strong or weak. A few examples are given here. In a violin of the ordinary type, no matter whether it be large or small, the proportions will be found to coincide with the above statement, while a highly arched violin has a less slanting and less tightened beam than the latter. In the case of wood of a thickness less than 1½ m/m., the beam should be 1 to 2 m/m. more towards the interior, and also be placed from 3 to 5 m/m. more slanting, and must in that case also be from 1 to 2 m/m. thicker. A bass-bar under strong tension gives a sharp and clear tone, while one of less tension gives a fuller and softer one. With bass-bars of the height of 12 and even 15 m/m. (so-called acoustic bass-bars), it is not

possible to achieve any success. The fixing of the bass-bar completes the interior construction of the violin, and consequently the glueing-on of the belly can now be proceeded with.

XI. THE HEAD OR NECK.

In Fig. 8 we have a very beautiful model, representing as it does a perfect specimen of Stradivarius. Its form can be obtained by exactly copying the external outline and the measurements I—XV. The inner curve of the head must be worked out as shewn in Fig. 8 *b*. The back at the head (Fig. 8 *c*) should be 4 m/m. thick on the upper side and gradually increase by 3 m/m. towards the under side, so that at this point it reaches a thickness of 7 m/m. The peg-holes must be placed exactly as shewn in the model. If they have short heads, they can be placed a few millimetres nearer together from A to G without destroying the appearance of the instrument. The wood for the head and neck must always be so chosen that the grain and surface lie horizontally.

XII. THE DIMENSIONS, LENGTH OF NECK AND BODY.

None of the old violin makers have attached more importance to the right position of the F-holes than Stradivarius; hence we gather that he fully recognised the importance of the dimensions of the body, and in his violins we always find that the same measurement is retained between the interior incision of the F-holes and the upper edge. We shall see later on the great advantages that would accrue to the musician, if all violin makers would observe the same rules in the adjustment of the dimensions. I repeatedly have

cut off the necks of hundreds of violins, and by correcting the proportions have made the possessors of them entirely contented. How many a student has drudged on through life with a badly proportioned instrument, and in consequence has never succeeded in obtaining that certainty on his instrument after which he has diligently striven. We must now, however, enter rather more into particulars.

I hope that what is to follow, may enable everyone to judge and prove for himself, whether his violin has the correct dimensions or not. We will adhere to the measurement accepted by Stradivarius (*see* Fig. 1 *a a a*), which is exactly 195 m/m. from the upper edge to the incision of the F-hole, and call it the normal measurement. From this we learn that the length of the neck, that is to say, the distance from the lower edge of the nut (the point where the finger-board begins) to the upper edge of the belly (*b b*) should be exactly 130 m/m., and the whole length of the body should bear the same proportion to the length of the neck, as 195 m/m. bears to 130 m/m., or to put it still more plainly, if we take the total of the two lengths, namely 325 m/m., and divide it by five, the length of the body should be equal to three of these parts and that of the neck to two of them. Should a violin have a longer or shorter body measure than that given above, the neck must still be in proportion with it of two to three, that is to say, if the whole measure be divided into five parts, two of such parts will give the length of the neck. By these means, correct dimensions will be obtained, and a performer will easily accustom himself to the proportionate position of the neck, and forthwith obtain certainty of execution. If only the proportion of the neck to the body be correct, a performer will scarcely notice, whether the whole measure from the bridge to the upper nut is 5 to 10 m/m. longer or shorter.

Great care must be taken in placing the upper end of the finger-board; it should be placed exactly at right angles with the under curve of the head (*a*), a point which is often paid very little attention to, and yet is one which is of the utmost importance. For instance, if the upper nut be placed too far beyond the angle (*a*), the hand must of necessity be stretched backwards in an uncomfortable position, or the fingers will fall too high upon the strings. On the other hand, if the nut be placed too low, the hand has no certain position upon the curve of the neck, and consequently will play flat in the first position and sharp in the third. It has often been said to me by musicians, and especially amateurs, that their violins played sharp in the first position and flat in the higher ones, and the contrary also has often come under my notice. The sole cause of these imperfections is the disproportionate relation in the length of the body and the neck, for whatever may be the distance between the bridge and the nut, whether long or short, the position of the different tones themselves is exactly determined by the laws of acoustics, and always remains in the same relation to the vibrating string.

I have given in Fig. 12 the exact position of the tones on the A-string, according to the normal measurement of 325 m/m. given above. The first tone played (B flat) is always exactly the eighteenth part of the whole length of the string from the nut to the bridge; the second tone is the eighteenth part from the first tone, and so on. If the finger-board is 268 m/m. long, the high E on the A-string will coincide with the lower end of the same. The above-mentioned imperfection is also caused by the neck being either too long or too short; in the first case a performer would play too sharp in the third position, and too flat in

the second; in the higher positions also, he would have difficulty in finding the correct place for the fingers.

XIII. THE FINGER-BOARD AND NUT.

Both these portions of the instrument must be made of ebony (Fig. 12). Before the finger-board is glued, the surfaces to be joined must be made particularly smooth. The length is 268 m/m. in an instrument of normal size, and in those which are longer and shorter, the necessary proportion is easily determined. The width of the upper end, near the nut, is 24 m/m., while at the lower end it measures 45 m/m.

The curve at the nut should be the same as the curve of the bridge, the thickness being from 4 to 5 m/m. Whilst the centre of the finger-board should form a straight line lengthways, it must be hollowed out under the E-string equally to the depth of 1 m/m., and under the G-string to $1\frac{1}{2}$ m/m., in order to prevent the jarring and rattling of the strings. The thickness of the nut must be 5 m/m. on the under side and 4 m/m. on the upper. The distance between the two outer string-grooves must be from 16 to 18 m/m. The strings lie at the nut (*a*) in the case of E, A, and D-strings at a distance of $\frac{1}{2}$ m/m. from the finger-board, the G-string 1 m/m. The thickness of the neck, including the finger-board, is 18 m/m. at the upper curve (Fig. 8*b* I.) for a hand of ordinary size, and 24 m/m. at the lower curve (Fig. 8*b* II); but this thickness can be altered according to the wish of the performer.

XIV. THE POSITION OF THE NECK.

The neck of the violin must be regulated according to the width of the finger-board. It must be cut about 7 m/m.

longer than the length required, when in position, in order to allow for its insertion in the block; the entire length of the neck from the nut to the end should measure 135 m/m. When this has been duly arranged, the neck can be fitted into the block. The small semi-circular elongation of the back of the violin, in common with the upper block, serves principally to support the neck and keep it in position, at the same time giving the performer a correct hold.

The finger-board having been glued to the neck, it is of the utmost importance that the latter should be fitted in very carefully, so that it protrude 5 m/m. from the belly (Fig. 8 *e*).

If the gauge be placed on the centre of the finger-board in the line *a a* (Fig. I and II), the end *a* (Fig. 9, third plate) should fall exactly on the line of connection between the innermost excisions of the F-holes, having its centre under the place where the bridge stands, so that the finger-board may exactly coincide with the measure.

This arrangement gives us not only the correct position of the finger-board, but also, as we shall see later on, the right height of the bridge, 35 m/m., and also the suitable position of the strings according to their height. The measurement marked upon the gauge (Fig. 9), viz.: from *a* (beginning of the nut) as far as the upper edge of the belly *b* (end of the neck) and thence to *a* (place of the bridge) must be in such proportion to one another as to give the violin practical dimensions and height of bridge.

XV. THE TAIL-PIECE (Fig. 11).

This part of the instrument exercises a great influence on the tone, although the fact is doubted by a great many

performers. I will endeavour to briefly demonstrate my idea upon the subject. In the first place, I would remark in reference to the shape and size of the tail-piece that the upper curve must resemble the curve of the bridge.

The semi-circular ridge at the upper end is called the saddle and must project about 1 m/m. The upper and movable end of the tail-piece is not arranged at right angles with the middle line of the same, but inclines about 1½ m/m. towards the G-string. This is done in order to balance, so to speak, the crooked position of the tail-piece which has been occasioned by the greater tension of the E-string in comparison with the G-string, and also to keep the upper edge of the tail-piece parallel with the upper edge of the bridge, which is very necessary to the elegant appearance of the lower portion of the violin. The space between the incisions for G and E-strings should be 30 m/m. The length of the strings below the bridge from the upper edge of the same to the saddle on the tail-piece should be 55 m/m., and then the A-string behind the bridge will give the high E. If the proportion of the tail-piece to the bridge be changed, that is to say, lengthened or shortened by the use of a larger or smaller tail-piece with the same length of the tail-piece fastener, the tension of the strings also becomes altered, and the tone and vibrations are thereby affected.

If, for instance, the tail-piece is so constructed that the portion of the A-string behind the bridge gives F, the other strings must also be correspondingly slackened, for the tension of a string reaches not only from the bridge to the nut as many suppose, but from the tail-piece to the peg. In consequence of this, the pressure of the strings on the instrument can be increased or lessened by means of a longer or shorter tail-piece, whereby the tone is correspondingly modified. The gut for the tail-piece should be from 1½ to

2 m/m. thick. The before-mentioned variations of tone can also be obtained by the lengthening or shortening of the gut of the tail-piece.

The rest, over which the gut passes, must be made of ebony and be 40 m/m. long by 5 m/m. wide, and must rise 3 m/m. from the belly. The button, round which the gut passes, must also be made of ebony, and has to be inserted into the centre of the lower block.

XVI. THE PEGS.

These are generally made of ebony, and care must be taken that they are inserted exactly in the places marked in Fig. 8. The distance of the pegs from the upper edge of the outer side of the violin head should not be more than 10 m/m. The holes in the pegs, through which the strings pass, should be 2 m/m. from the inside of the head. The outer ends of the pegs should be level with the sides of the head and be slightly rounded off.

XVII. THE BRIDGE (Fig. 10).

The bridge is made of maple and should be 40 m/m. wide and 35 m/m. high, at the bottom it should be 4 m/m. thick, on the top $1\frac{1}{2}$ m/m. The width of the feet is not to exceed $9\frac{1}{2}$ m/m. (Fig. 10 *a*).

The feet must be fitted exactly to the belly and towards the back should be sloped sufficiently, so that on the lower side of the bridge they form an exact right-angle with the centre line of the belly.

It is advisable to powder the feet a little with chalk to prevent the bridge from being so easily displaced as would otherwise be the case.

The feet of the bridge should stand exactly on the line of connection between the notches of the F-holes (Fig. 7 *a a*) and at an equal distance from them on either side. The notches on the bridge for the E and G-strings are to be 34 m/m. apart.

The lower end of the E-string should not be more than 4 m/m. from the finger-board at the very most, that of the G-string about 6 m/m., but never more. The height of the strings is, however, very often adjusted to the wish of the performer. Herr Joachim, the great violinist, always adopts the above measurements on his violins.

A highly arched violin does not require so high a bridge as a flatter one, whilst an instrument with a thin belly needs a thicker bridge than one of stronger make. These proportions must be carried out very precisely, as well as the measurements with regard to the hardness or softness of the wood and the strength or weakness of the bridge.

If the bridge be thick below and thin above, the tone will be clearer than it would be if these conditions were reversed. If the heart in the bridge be cut rather small and high up, the tone is rendered harder, a large heart cut in the centre of the bridge will make the tone fuller. The use of hard wood for the belly necessitates soft wood for the bridge, and loosely grained and soft wood needs a hard wood for the latter.

XVIII. THE SOUND-POST.

The sound-post must be made of pine; in a violin with a belly of normal thickness its diameter should be 6 m/m. and show by its year-rings an age from 10 to 12 years. With a thicker belly it should be made about 1 m/m.

less in diameter. It must also be shaped so that both ends exactly fit the arch of the violin. When the sound-post has been placed in position, its year-rings should be at right angles with those of the belly, and furthermore, it should be of such a height as to raise the belly ½ m/m.

The sound-post must be placed upon the belly under the outer edge of the E-string foot of the bridge, but it should rest upon the back from 2 to 4 m/m. nearer the centre. In its normal position the sound-post must be placed nearer to the tail-piece than the bridge by about 2½ m/m., that is to say, by about the thickness of the belly.

If one wishes to procure any other tone than that obtained by the above-mentioned position, the latter should not be altered, at most, by more than 1 to 2 m/m. A sound-post only ½ m/m. longer, renders the tone sharper and thinner, while if it be approached nearer the bridge, the tone becomes clearer and more acute. If the sound-post be moved more towards the centre of the instrument, the G-string sounds clearer and firmer, but the E-string on the other hand grows slacker and softer; if the sound-post be moved from its normal position about 1 m/m. further below the bridge, the tone will be softer, but at the same time more muffled.

I should like to warn very strongly all performers, whether professionals or amateurs, against attempting to alter the position of either the sound-post or the bridge themselves, for such attempts will in most cases be endless, and very seldom lead to the desired end. I could adduce proofs of this in many cases, but I will give only one here by way of example. The celebrated violinist Ole Bull who, after the loss of all his property in America in the year 1860, took up his residence with me in Hanover, could not play for an hour together, without experimenting with his violin,

it having become a perfect passion with him to be always altering the position of the bridge and the sound-post. Indeed, these experiments often lasted until quite a short time before the beginning of a concert, and usually ended with a malediction on himself and his otherwise precious "Josephi" (Joseph Guarnerius del Gesù).

Still, I must confess that I learned a great deal from his many researches by dint of observation. When Ole Bull was playing at the Theatre in Hanover in cold weather, he always breathed a few times into the F-holes of his violin before the curtain rose, in order to warm the air in the interior of the instrument, as he was of opinion that in consequence the violin spoke better. He may have been right. He also carried E-strings in his waist-coat pocket during wet weather, because he maintained, and perhaps justly, that they then lasted better.

XIX. THE STRINGS.

It is very difficult to decide on the quality of the strings; their being light or dark-coloured has no influence on their durability. The natural colour of the strings is dark, those of a lighter shade having been sulphured to render them so. The Italian strings are at present unrivalled, but care should be taken that they do not feel too hard. The choice of strings according to their thickness really depends on personal preference, but as a rule those only of medium size should be chosen, which according to the French measurement of strings would be 14 degrees for the G-string, 23 for the D-string, 14 for the A-string and 12 for the E-string.

The larger the violin is, the weaker should be the strings. The notion that a half-sized violin should be thin-stringed, is quite erroneous, it should, on the contrary, have

strings as strong as a full-sized violin, for owing to the shorter length, the strings, if they be a weak set, become too loose and do not give a true sound, and offer insufficient resistance under the pressure of the bow.

XX. THE VARNISH.

There has been for many years a warm and to a certain extent undecided discussion going on, as to whether the varnishes used by Italian violin makers were oily and slow-drying ones or spirit varnishes. To investigate this matter still further, and to arrive at a correct decision, will have to be left to the future.

I am, however, of the opinion that the old masters made use of spirit or turpentine-oil until the middle of last century, but never of linseed-oil or turpentine-oil varnish, as has been often asserted.

My opininon is supported by the following fact. In the year 1860 I had the good fortune to buy a real Nicolas Amati lute which, although very much knocked about, still retained a thick varnish of a most beautiful gold colour. For my information I took the varnish off, in order to submit it to the analysis of a clever chemist who, being a talented amateur violinist and also a pupil of Spohr, showed great interest in the matter and communicated to me, as the result of his investigations, this fact that among the quantity of varnish which I had placed at his command, there was not a trace of evidence which could lead to the conclusion that linseed-oil varnish had been employed. In my own researches I found that the varnish was immediately dissolved in spirit of only 90 per cent., while in oil of turpentine and linseed-oil it was scarcely affected, and by boiling only a small portion was removed. Again, it is not

probable that Stradivarius, in whose workshops about 3000 violins were constructed, would have employed linseed-oil varnish, seeing that it would have required, in each case, six months for the violin to get thoroughly dry.

There are many resins which can be dissolved in spirit or oil of turpentine and used as a varnish, but the preference is generally given to spirit-varnish, as it dries more quickly. If the spirit or turpentine-oil has evaporated, only the resin remains.

The greatest attention must be paid to the relative hardness of the resin and the wood, for both should be of equal density. Hard resin hinders the vibration of the wood, and consequently the quality of tone suffers.

In my opinion shellac is quite useless for varnishing, it being much too hard, but nevertheless it has been employed from 1770 until the present day, in spite of the fact that the best Italian instrument might be completely ruined by being varnished with it. In all Italian instruments the old varnish is always very porous and soft, and can easily be dissolved by the application of spirit, while, on the contrary, it requires great labour to effect the same with turpentine-oil.

Many people affirm that the art of mixing the old Italian varnish which so charms us with its brilliancy and transparency, is no longer known, in fact that it is for ever lost. I am, however, of a different opinion and maintain that our modern varnishes are quite equal to the old, but what we have until now been unable to produce scientifically, is the golden-brown underground which the wood of older violins has acquired through age and other influences. The proof of this I have practically demonstrated by varnishing old instruments with new varnish, in imitation, with such success as to arouse the wonder of connoisseurs, the varnish being quite as transparent and brilliant-coloured as that used for violins in the last century.

To one other point I should like to call the attention of the reader. In repairing old instruments of the time of Stradivarius, I have found that an extraordinary cleanliness and lustre is obtained by rubbing them with fine glass-paper, which is not the case with Tyrolean and German violins of the same period. At a later period this peculiarity was not met with so frequently and from the year 1750 not at all. This fact I primarily attribute to the action of the resin on the wood, being also of opinion that the fine dust of the same gets firmly embedded in the pores of the wood, and in this way, in course of time, a more or less thick coating is formed.

For one of these practical experiments I took a violin which I had made myself and the tone of which, through years of constant use, was therefore quite familiar to me, and gave it a coating of melted resin on the inside. After this was thoroughly dry and hardened, I polished the interior and remarked the before-mentioned smoothness and brilliancy, the obtaining of which firmly convinced me that I had discovered the truth of the matter. Although, after the glueing-on of the belly, all the former conditions of the violin remained unchanged, yet I was astonished to find what a common-place squeaking tone the instrument had acquired, thus proving to me that with the melted resin I had obtained in the end exactly the opposite effect to that which I had hoped for. I was obliged to rest contented with my failure for a long time, when a lucky chance came to my help. It was this. I received a real Caspar da Salo violoncello to repair, which had never been opened and seemed to have been very little played upon, for on it I found an old bridge which I kept as an ornament and curiosity, and which, on closer examination, I found was varnished.

When I opened the cello, it was proved without a doubt

that the interior had also received a coating, probably to protect it from dust, etc. The celebrated old violin makers, in so doing, have pursued the right course. This discovery also corroborated my own supposition, that the old masters varnished both the interior and bridge of the instruments they made.

Now, in order to obtain a ground-priming, I paint the violin, when the wood of which it is constructed is in its natural state, three times with pyroligneous acid, with which a golden-brown underground is obtained, then follows a single coating of spirit and balsam of Peru in equal proportions, and after this one or two coats of a weak solution of gamboge or anotta, and finally, over all this I lay on 20 or 30 coats of varnish, according to the thickness required, and which I prepare as follows: —

Dissolve three parts of sandarac and one of mastic in spirit, and in order that it may be laid on more easily, add to each half a litre*) of varnish, ten drops of oil of turpentine. The colouring of the varnish I obtain from turmeric and bright red sandal-wood by means of spirit, using more or less of it, according as to the lighter or darker tone required; if a brown varnish is required, some soot from turpentine-oil must be added to the spirit.

I have made innumerable experiments with other resins and colouring matters, but in the end I always return to those mentioned above as the best to be used. Dragon's-blood must not be employed, the colour not being fast.

When the varnish is dry, it must be very carefully polished with finely powdered pumice-stone and linseed-oil, applied with a piece of felt.

---

*) Half a litre is very little less than a pint.

XXI. THE CLEANING AND CARE OF THE VIOLIN.

The instrument must always be kept thoroughly clean and after use should be carefully wiped with a silken duster. If any dirt should adhere to it in spite of this precaution, it can be easily removed by gently rubbing it with a piece of linen, moistened with water, and afterwards wiping it over with oil of turpentine. The resin which accumulates on the finger-board and strings can in case of necessity be removed by the application of a little spirit, or better still, by that of Eau de Cologne, but great care must be taken in the application, so that the spirit does not touch the varnish of the belly. Spirit will also clean the strings and remove from them the effect of perspiration; the bridge may also be cleaned with it from time to time, but as stated before, it must be done cautiously, especially in the case of old and valuable instruments of the time of Stradivarius. The more recently constructed violins are mostly varnished with shellac, and consequently are not at all or, at most, very little affected by the application of spirit.

The interior of a violin should also sometimes be cleaned; this can be done by putting through the F-holes two or three handsfull of coarse kitchen salt; these should then be covered with a cloth and the salt well shaken about, as it will thus collect all the dust, resin and other dirt which may be in the violin, and when shaken out will carry all these impurities with it. The strings need not be taken off in order to effect this.

XXII. THE BOW.

The rank of François Tourte among violin-bow makers is as prominent a one as that of Stradivarius among violin

makers. Each has supplemented the other. Tourte died in Paris in the year 1835 at the age of 88, after a life of usefulness almost as long as that of Stradivarius. He brought the making of bows for stringed instruments to such perfection, that those bow makers who have succeeded him, have never deviated very far from the models he left.

I shall here make a few observations on the characteristics of real Tourte bows which have crossed my path.

The quality, as well as money value, of a bow seems entirely to depend upon its shape, whether the stick is round or angular. The whole length of the bow from the point to the end of the nut should be 73 to 74 centimetres. The length of the hair from the lower part of the head to the nut should measure 63 to 64 centimetres; the height of the head, including the stick and little plate, should be 23 m/m; the height of the nut with the stem to the outer ring where the hair begins 26 m/m.; the breadth of the hair on the nut should be 11 m/m. and on the head 10 m/m. Tourte used from 80 to 100 hairs for each bow, but now from 150 to 160 are taken.

The stick is made of pernambuco-wood and the nut of ebony; tortoise shell is however sometimes used for the latter. The decoration may be in German silver, silver or gold, according to the taste of the possessor.

The stick must be cut straight and lengthwise with the year-rings, and is manipulated in such a way that the side-view of the bow shows the horizontal lines. In this condition the prepared stick must be held over a charcoal fire, be gradually and equally heated, until it can be scarcely retained in the hand, and then it must immediately be bent across the knee to such a degree, as to allow the hair of the finished bow to lie upon the stick. To accomplish this successfully, a certain amount of practice and caution is

required. The weight of a bow when finished should not exceed 54 to 57 grammes.

Tourte never polished nor varnished his bows, but only rubbed them smooth with pumice-stone and linseed-oil. If varnish or polish of any kind is ever found on one of his bows, it has been put there by other hands than his.

It has often been asserted that Tourte only left the bows unpolished and unvarnished from indifference, and I must confess that I also was once inclined to this opinion until experience taught me better. About 30 years ago I bought a beautiful Tourte bow which I handed to Herr Joachim to test.

It seemed to him a little too heavy and I, in my want of experience, imagined that I could easily meet the wish for diminished weight by a little work. I therefore commenced to work with a file upon this master-piece, but I found the outer layer of the wood as hard as iron, so that I had a great deal of trouble to lessen the circumference of the stick. This circumstance surprised me at the outset of the work, as in the making of new bows it never occurred to me before. I was in great fear, however, at the conclusion of my troublesome work, for I found that the bow had lost all elasticity and power.

Later on, the opportunity presented itself to me of proving that pernambuco-wood when exposed to the air hardens very rapidly, and I am therefore convinced that this fact was known to Tourte and that consequently he only rubbed his bows with linseed-oil, in order to leave them open to the influence of the air, so that the sticks might become hardened and strengthened.

If an old bow has become slightly twisted, which may happen with bows of the best make, this fault can be rectified by cautiously bending it back to its original form

over a charcoal fire, and the bow will regain its former elasticity.

If any of my readers desire to study more closely the history of stringed instruments, I can recommend to them very highly the work upon the subject from the pen of Julius Rühlmann.

Göttingen, Druck der Dieterich'schen Univ.-Buchdruckerei von W. Fr. Kästner.